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ABSTRACT

Three kindergarten children and one first-grade student used computer programs to spell words in isolation and in stories they wrote. Eventually, all of the children, even those who were initially non-readers, were able to write some stories in standard spelling. As the children made progress toward writing words in conventional spelling, they showed evidence of developing phonological spelling strategies similar to those that have previously been reported for children using paper and pencil. At the same time, however, children also showed evidence of developing visual spelling strategies in more detail than has previously been reported. In particular, evidence was found of visual spelling strategies occurring before the transitional stage in which they had previously been seen. Evident patterns of spelling development were more consistent with multidirectional than with unidirectional views of written language development. Findings suggested that computer programs are a viable option for teachers who wish to develop the visual spelling strategies of young children. Children's visual classifications are discussed in detail, focusing on visual categories, analogical wholes, analogical parts, standard spelling of a significant segment, letter reversals, visual and semiphonetic categories in the same phase, visual and phonetic categories in the same phase, and sequences with visual categories. (Author/RH)

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Visual Spelling by Young Children on the Microcomputer: A Multidirectional Development with Phonological Spelling

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Abstract

Three kindergarten children and one first grader used computer programs to spell words in isolation and in stories they wrote. As the children made progress toward writing words in conventional spelling, they showed evidence of developing phonological spelling strategies similar to those that have previously been reported for children using paper and pencil. At the same time, however, they also showed evidence of devoloping visual spelling strategies in more detail than has previously been reported. In particular, there was evidence for visual spelling strategies that occurred before the transitional stage in which they had previously been reported. These results also suggest that computer programs are a viable option for teachers who wish to develop the visual spelling strategies of young children.

Visual Spelling by Young Children on the Microcomputer

Much of the recent research in spelling has centered around phonological and visual influences, or strategies, in the development of children's spelling (Barron, 1980; Frith, 1980; Frith & Frith, 1980; Marino, 1980; Nolin & McCartin, 1984; Radebaugh, 1985; Read, 1986; Read & Hodges, 1982). The phonological strategy uses the sounds heard in words to write letters while the visual strategy uses what was seen in words. According to these studies, phonological strategies develop before the visual strategies, and good spellers use visual strategies while poor spellers stay with a phoneme-to-grapheme strategy. Elaborating on these findings, some investigators have described spelling development in terms of stages (Anderson, 1985; Gentry, 1981, 1982, 1987; Henderson, 1985; Morris & Perney, 1984; Morris, Nelson, & Perney, 1986). Gentry (1982), for example, describes a developmental sequence of precommunicative, semiphonetic, phonetic, transitional, and correct spelling.

In these stage descriptions, the precommunicative stage shows no letter-sound correspondence, and the semiphonetic stage shows a partial mapping of phonetic representation. In the phonetic stage, "Letters are assigned strictly on the basis of sound, without regard for acceptable English letter sequence or other conventions of English orthography." This phonetic stage shows a fairly complete mapping of letter-sound correspondences in which letter names are used for the long or tense vowels, A and E are commonly used for the short or lax front vowels, and one of the consonants in a blend is often omitted. Among the characteristics of the transitional stage, "Vowels appear in

every syllable," e.g. EGUL intead of the phonetic EGL/eagle; "Common English letter sequences are used," e.g. YOUNITED/united; and common vowel patterns appear, e.g. TIPE instead of the phonetic TIP/type. In addition, "Transitional spellers present the first evidence of a new visual strategy; the child moves from phonological to morphological and visual spelling," e.g. EIGHTEE instead of the phonetic ATE/eighty; and "Transitional spellers may include all appropriate letters, but they may reverse some letters," e.g. HUOSE/house (Gentry, 1982, pp. 196-197).

In this progression of spelling development, Gentry does not explicitly identify examples of visual influences until the transitional stage even though we might reasonably interpret some of the evidence that Gentry presents as signs of it. For example, Gentry allows that correct spellings may account for 0 to 50% or more of the words in semiphonetic writing, depending on the writer's exposure to reading and instructional intervention. Some of these correct spellings, such as those that depend on exposure to reading, could be attributed to visual influences, even though some correct spellings may have been learned by rote oral routines like "C-A-T spells cat." However, Gentry holds that "Developmental spelling levels may be determined only by observing spelling miscues, not by observation of words spelled correctly" (p. 196). Children's spelling of <u>-s</u> for the plural morpheme has also been regarded as an early visual influence (Marsh, Friedman, Welch, & Desberg, 1980, p. 346). In addition, it is important to keep in mind that all phonological strategies require children to recall the visual form of at least some of the letters they have seen which correspond to the sounds they

hear. This means that the development of more sophisticated phonological spelling also reflects the use of more visual information.

Gentry's understatement of visual influences may be even more extensive when we consider the variety of backgrounds children may be exposed to. Gentry acknowledges the importance of Bissex's intervention for Paul's short stint as a semiphonetic speller as well as reading and instructional experiences for the proportion of correct spellings; but perhaps backgrounds should be considered throughout the child's spelling development for all of the child's spelling performances. For example, Gates and Chase (1926/1976) reported that congenitally deaf children were better spellers than hearing children of an equivalent reading level. Gates and Chase attributed the spelling skills of the deaf to their "peculiarly effective type of perceiving, of reacting visually to words" (p. 349). The superiority of these deaf children seems at least partially due to their earlier and/or greater reliance on visual strategies.

If background influences can make a difference, it would seem worthwhile to investigate the effects of spelling activities that emphasize the visual information in spelling on children who are not physiologically impaired. If such activities help to develop visual spelling and they can be used in the classroom, this would have important practical implications. Good spellers must use visual strategies, and many children have difficulty in making the transition from phonetic to visual strategies (cf. Radebaugh, 1985). Accordingly, the following examines children's spelling development under the influence of computer programs

that present a considerable amount of visual information in addition to phonetic information.

Method

Subjects and setting. We worked with four children, one first grader (Julian, 6 years, 4 months) and three kindergarteners (Beth, 6 years, 1 month; Kathy, 5 years, 5 months; and James, 6 years, 3 months) in a day care center they attended after school. An initial assessment in reading a three sentence paragraph based on the vocabulary words in the computer programs showed that Julian read aloud all the words correctly, James read most of the words, Kathy read none of the words, and Beth named some letters instead of reading the words. We worked in a room that was rarely used by the other children while we were there.

Apparatus. The children worked on an Apple IIc computer with an Echo General Purpose Speech Synthesis Unit. The use of "pronounced" in the following procedures refers to pronunciation by the speech synthesis unit.

Instructional Procedures. Computer programs, which had previously been developed in Terrapin Logo by the first author, were used for copying, spelling, and story writing (Moxley, 1986; Moxley & Barry, 1985; Moxley & Barry, 1986). The Direct Copy and Spell programs, which included read-write cycles (cf. Lee & Sanderson, 1987) with immediate correction (cf. DiStefano & Hagerty, 1985), and one of the three programs for writing stories--Picturewriting, Word Pictures, and Story Editor--were used in every session.

In the Direct Copy program, 10 to 15 words that would be useful in writing sentences in the story writing programs, or had been requested by the child, were entered in the program vocabulary. These words were changed weekly as the child learned to spell and read the words correctly. One at a time in random order without replacement, 10 of these words were then displayed on the screen and pronounced. Pressing the return key at any time would repronounce the word. As the child copied the word, the letter for each key press was displayed on the screen beneath its corresponding location in the model and recorded by the computer. Correct letters remained on the screen and incorrect letters disappeared after a brief appearance until the entire word had been copied correctly. The model was then highlighted, pronounced, and one or more stars appeared, corresponding to the cumulative number of words copied correctly, until ten stars were shown or approximately 4 minutes had passed on a wind-up kitchen timer. The children soon completed their 10 words before the time limit expired.

The Spell program was similar to the Direct Copy program except the model word disappeared once a correct letter key was pressed. The word reappeared when an incorrect key was pressed or when the child pressed the return key. The child thus always had the option of studying the visual appearance of the word before pressing a key.

After completing the above two programs, a printout of all the words presented, all the keys pressed, and the cumulative number of seconds between key presses was shown to the child. See Figure 1. Positive comments were given for improvements in

speed and spelling accuracy. Words read without help were underlined, and help in sounding out other words was given.

Insert Figure 1 about here

In the most commonly selected story writing program, Word Pictures, the children could move the cursor anywhere on the screen for placing their picture. The children had five minutes to put their pictures on the screen and five minutes to write a story about them. They could copy from word cards to produce their pictures, but they were to spell the words in their stories as best they could. Usually, we wrote down what they said about their pictures and dictated it back for them to write, although the children often preferred to compose as they wrote when they became more proficient spellers. Since the children were often reluctant at first to spell words they were unsure of, we said we would help them to revise their words before they were printed out and taken home. Records were kept of both the original and the revised writing. See Figure 2.

Insert Figure 2 about here

We worked with the children in month-long phases that ended in a spelling test. Each phase consisted of approximately 20 sessions each, 4-5 days a week, for approximately 20 minutes per session. We started out in October of the school year by working

with Julian for one phase and then added Beth in November when we went to the next phase. We continued adding children to work with in this manner until a child had completed four phases or until the academic year ended, as it did after James's third phase.

Results

The data reported here is based on the children's spellings in their dictated spelling tests at the end of each phase and in their stories within each phase. The children had more opportunities to spell words in their stories than in their tests, and most of the following data, therefore, is based on the spellings in their stories. One interesting difference between the two conditions for spelling words was some reluctance to use creative spellings on tests. For example, Beth would often not even try to spell words in her tests that she was unsure of, although she was willing to attempt many of these same words in her stories, until her fourth test when she attempted all the words.

All the children were eventually able to write some stories in standard spelling. This was true even for the two non-readers at the beginning of the study, Beth and Kathy, who worked with a more limited spelling vocabulary. When stories were written with all words spelled correctly, it was often the case that the same or similar words were repeated. This made their stories easier to compose and read as well as easier to spell. See Table 1 for some contrastive examples of spellings in stories written earlier and later.

Insert Table 1 about here

In addition, all the children showed development in both phonetic and visual spelling categories. In general, their phonetic spelling development was similar to that which has previously been reported for children working with paper and pencil. However, examples of visual spellings like reversals, which Gentry finds occurring in the transitional stage as the first evidence of a new visual strategy, appeared from the beginning and continued to appear along with spellings that would be classified as semiphonetic and phonetic. Several standard spellings also appeared for the first time in every phase. Since the literature on children's spelling development has primarily emphasized phonological categories, the visual classifications for the children's spelling will be presented below in some detail.

Visual Categories

The following visual categories of creative spellings are based on examples from the children's spelling. It should be noted, however, that just as phonological spelling categories have some visual influence in the printed forms that are recalled for sounds so too visual spelling categories have some phonological influence in the sounds that are heard for words. No category, or stage, should be interperted as representing a purely visual or a purely phonological influence. Rather, the following categories represent a collection of instances in which

the visual component is at a stronger strength than in phonological categories. Further, each visual category is represented by the collection of spellings as a whole, and individual spellings in these categories may have an alternative phonological explanation. This caution, of course, also applies to spellings that previous stage descriptions have classified as semiphonetic or phonetic. Some instances of these spellings might also be interpreted as representing visual categories. The most confident estimate of a child's spelling strategy, therefore, should be made within the context of the overall patterns of the child's spelling.

Analogical wholes: the standard spelling of a related word.

This is a new category from those that are commonly described in transitional spellings. The influencing word may sound alike, look alike, or be an alternative form of the word heard. Some of these spellings may also result from phonological strategies that produce words which coincidentally resemble other words. Other spellings like RUN/ran, RUNS/run, RAN/run, HOUSE/horse, and INDIAN/indians are more clearly under the control of similar word forms.

Julian spelled RUN/ran, SEES/see, RUNS/run, COLD/cloud, and HOUSE/horse, in tests and INDIAN/indians, BYE/by, DAD/did, GET/getting, and BENT/bunny in stories. Beth spelled PAT/sat, PAT/put, and RAN/run in tests and TO/two, SLED/sliding, WASHING/watching in stories. Kathy spelled SEES/see, HERE/there, TO/two, SHOWED/showing, SWAM/swim, WITCH/with and ONE/won in tests and IS/it, SIDE/snowman, STAR/stars, WONT/went, DAD/down, HOG/showed, TO/too, TOO/to, BARN/bear, and WISH/with in stories.

James spelled HOUSE/horse, SEAT/sat, SWIM/swam, and SWAM/swim in tests and BYE/by, TRIKCS/tracks (a possible influence from tricks) and CARS/chairs in stories.

Analogical parts: letters from related words.

Among the many sources of influence for analogical parts are a similar sounding word like the SEE in PAPSEE/Pepsi, a word commonly used as a segment in other words, like the MAN in CHRISTMAN/Christmas, a related morpheme like the -S in TAKS/track, a recently spelled word, and various combinations of the above.

In tests, Julian's spelling of RUNNS/runs and WALR/water seems to have been influenced by running and walk respectively, SWRING/swing may have been influenced by ring and PAPSEE/Pepsi may have been influenced by see. In stories, CHRISTMAN/Christmas may have been influenced by man a stand alone word and a common segment in words like snowman. WHITCH/witch may have been influenced by which since witch was previously spelled the standard way.

In stories, Beth spelled ONECI/WSA/ONES/once, which shows the influence of one, a word she commonly used to start many of her stories ("One day there was . . ."). WSA seems to represent a semiphonetic "Once a" (as in "Once upon a time . . .").

In tests, Kathy wrote NOWND/snowing and THEYER/that's, indicating a possible influence from the -ed form of snow and from they respectively, and TRUICK/trick, indicating an influence from truck as well as a possible extra vowel in sounding out. In the first phase of stories, Kathy wrote THC/it which seems to

have been influenced by THE which she had already spelled twice in that sentence.

In stories, James spelled BOT/bird, which was preceded by BOT/boat in the same sentence, RAIND/riding, which seems influenced by rained, TRAKS/track, an influence of the plural form, and CANPUTER/computer. The CAN in CANPUTER seemed to represent a strong semantic borrowing as though the meaning of computer was that it "can pute." James seemed quite surprised when the standard form was explained to him and was reluctant to revise his spelling. CONPUTER/computer was as far as he would go. He said he preferred CONPUTER to computer.

Standard spellings of a significant segment.

This category includes segments of words that are spelled in standard form while the rest of the word has some creative variation. Most of these segments are the inflections -ing, -ed, or -s. They may also include common morphemes like MAN or letter clusters perceived as a unit by the child like LOON.

In tests, Julian spelled ROKING/walking, SOWNING/snowing, SRE ING/swing (but not in GETINN/getting or TANKSGIVIN/thanksgiving), WOKS/walks, WATES/wants, HIVING/having, SOWNMAN/snowman, WENTED/wanted, WOHED/watched, BAYKED/baked, and BAYKS/bakes. In SRE ING/swing the ING is spatially separated even though in this case it did not represent the inflected form. In stories, Julian wrote, GOINGN/going, EASTTER/easter, and HIVING/hang. GOINGN appears to represent a combination of two distinct strategies for representing the ending of going: the ING segment and a phonetic ending with N which he had used previously with GON and GOEN. In BLOON/balloon on tests, the second

syllable is treated as a meaningful segment. Although ball would appear to have been a more likely candidate, the sound of ball is not heard in this word.

Beth spelled RNING/raining, WATEED/walked, WTED/wanted in tests and OTING/holding, MEKING/milking, RDTING/riding, SAITING/sitting, SAENING/standing, SARING/staring, YING/WLKING/walking, and EING/YAEING/watching in stories.

Kathy spelled SOWING/snowing in tests and ETING/eating, SIDNINING/sitting, and WRING/WINING/wearing in stories.

Although he had fewer sessions, James spelled more standard inflections than Kathy. He spelled FLEING/flying, FLEING/FLAING/flying, RADING/riding, SMALING/smelling, SEWMING/swimming, SWINING/swinging, WAERING/wearing, GATING/getting, HALDING/HALING/holding, MALTING/melting, and SMALING/smelling in stories.

Letter Reversals.

All of the children reversed the sequence of letters in some of their spellings. In most of these reversals, the letters were visually accurate except for their order. Many of these reversals were closely preceded or followed by a standard spelling. In rare instances, sounds were reversed. For example, EN CAS/chasing reverses the sounds of chasing.

Julian spelled AET/ate, which may also reflect an attempt to represent the diphthongal nature of the vowel /e/, SOWN/snow, SOWNING/snowing, SOWNMAN/snowman, TEERT/treat, AET/ate, BIDR/bird, COLD/cloud, GRIL/girl, PUGMR/Pilgrim, SWA/saw, SOWNBAL/snowball, FNECE/fence, PIAL/pail, and SIAL/sail in tests and EN CAS/chasing, BOFR/before, WATRE/water, KISD/kids,

GRIL/girl, and SCOOH/school in stories. Beth spelled AET/ate, DHTN/IDHT/the, SAE/ask, HRE/her, and TOW/two in stories. Kathy spelled SATR/star, REH/her, SEH/she WLEK/walk, SNWN/snow, WAETR/water, and TURACK/truck, which may also have been a sounding out of TUR for TR, in tests and FOLS/flower, OTU/outside, STRA/star, WAS/saw, HES/she, and TO GHTAR/together in stories. James spelled HRA/her, WLAK/walk CULOD/cloud, and TOW/tow in tests and RAOD/road, TRIKCS/tracks, and WAERING/wearing in stories.

Visual and Semiphonetic Categories in the Same Phase

Elaborations of visual spellings occurred along with early elaborations of phonological spellings. Some early occurrences of visual forms, like correct spellings and -s for the plural morpheme, have previously been identifed. However, the visual spellings described here show a much more extensive variety of visual influences.

In the first phase of his spelling tests, for example, Julian produced semiphonetic spellings for FLR/flower, HVN/having, HRSS/horse; and visual spellings in the form of reversals in AEFFTR/after, SOWN/snow, SOWNING/snowing, SOWNMAN/snowman and analogical wholes for RUN/ran, RUNS/run, SEES/see.

In the fourth phase of her tests, Beth produced semiphonetic SR/stir, WTR/water; and a visual reversal in SMW/swam and the standard spelling of significant segments in RNING/raining and WTED/wanted. In the third phase of her stories, she produced

semiphonetic SM/some, STRS/stars; and visual reversals in HRE/her, OEN/one, and WAS/saw.

In the first phase of her tests, Kathy produced semiphonetic THT/that; and a visual reversal in SATR/star and an analogical whole for SEES/see. In the fourth phase of her tests, she produced semiphoneic L/lights, T/turtle, W/water; and a visual reversal in TURACK/truck and an analogical whole WITCH/wish. In the first phase of her stories, she produced semiphonetic J/dropped, GRBJ/garbage, H/her, PK/picked, PLD/played, PRD/pretty, SHD/showed, T/took, WS/was; and visual reversals in CLHN/children, STRA/star and an analogical whole IS/it.

In the first phase of his tests, James produced semiphonetic CLM/climb; and a visual reversal in WLAK/walk and an analogical whole HOUSE/horse. In the first phase of his stories, he produced semiphonetic ACRKST/across, ANN/animals; and visual reversals in DNA/and, RAOD/road, a significant segment in FLEING/flying, an analogical part in RAIND/riding, and an analogical whole TRACK/truck.

In addition, the children often spelled inflections accurately in words where the rest of the word is a semiphonetic spelling. Beth, for example, spelled RNING/raining in tests and OING/holding, YING/walking and EING/watching in stories.

Visual and Phonetic Categories in the Same Phase

Visual spellings also occurred with phonetic spellings in the same phase. In the first phase of his spelling tests, Julian produced phonetic spellings for BRD/bird, HA/hay, HOD/hold,

RAN/rain, SAD/said; and visual spellings in the form of reversals in AEFFTR/after, SOWN/snow, SOWNING/snowing, SOWNMAN/snowman and analogical wholes for RUN/ran, RUNS/run, SEES/see. In the second phase of his tests, he produced phonetic GOS/goes and visual reversals in BIDR/bird, GRIL/girl, an analogical whole HOUSE/horse, and analogical parts in RUNNS/runs (from running) and PAPSEE/pepsi (from see). In the third phase of his tests, he produced phonetic THA/they, UNDR/under; and a visual reversal in SOWNBAL/snowball. In the third phase of his stories, he produced phonetic GREN/green, WENDO/window; and a visual reversal in WATRE/water. In the fourth phase of his stories, he produced phonetic FLIS/flies, GOS/goes, HI/high, VARRE/very; and visual reversals in GRIL/girl and KISD/kids.

In the fourth phase of her tests, Beth produced phonetic spellings for BAD/bed, MAT/met, TRK/trick; and a visual reversal in SMW/swam and the standard spelling of significant segments in RNING/raining and WTED/wanted. In the fourth phase of her stories, she produced phonetic LITO/little, THA/they, TIM/time, APAN/upon; a visual reversal in HRE/her, analogical parts in ONECI/once, ONES/once, and significant segments in RDTING/riding, YING/walking, WLKING/walking, EING/watching, and YAEING/watching.

In the first phase of her tests, Kathy produced a phonetic spelling for WAK/walk; and a visual reversal in SATR/star and an analogical whole SEES/see. In the second phase of her tests, she produced phonetic DAN/den, HAN/hen, TAN/ten; and visual reversals in REH/her, SEH/she and an analogical part in SHOWED/showing. In the first phase of her stories, she produced phonetic HOYS/house,

PLAD/played, THA/they; and visual reversals in CLHN/children, STRA/star and an analogical whole IS/it.

In the first phase of his tests, James produced phonetic SHN/shin, WAN/win; and a visual reversal in WLAK/walk and an analogical whole HOUSE/horse. In the third phase of his tests, he produced phonetic TARTEL/turtle; and visual reversals in BAER/bear and TOW/two. In the first phase of his stories, he produced phonetic BOT/boat, BI/by, NIT/night; and visual reversals in DNA/and, RAOD/road, a significant segment in FLEING/flying, an analogical part RAIND/riding, and an analogical whole, TRACK/truck. In the second phase, he produced phonetic BESID/beside; visual reversals in TRIKCS/tricks, WAERING/wearing, and significant segments in FLEING/flying, FLAING/flying, RADING/riding. In the third phase he produced phonetic MADO/meadow, SNAK/snake, TABAL/table; and a visual reversal in HORES/horse, significant segments in HALDING/HALING/holding, GATING/getting, MALTING/melting, SMALING/smelling and an analogical part in CANPUTER/conputer.

Sequences with Visual Categories

Many of the sequences in the development of a child's spelling for individual words showed more visual influences and a greater variety of visual influences than would be expected from standard stage accounts. For example, the last creative spelling before a standard spelling of the same word was not always a spelling that has been identified with transitional or phonetic stages. Sometimes the spelling was semiphonetic and sometimes the spelling showed a visual strategy but not one as close to the

standard spelling as would be expected from stage accounts of the transitional stage.

Before writing the standard spelling the next time he spelled the word, Julian spelled PIRSET/picture in stories. PIRSET is a non-phonetic scramble of 5 of the 7 letters in picture plus s, which may represent the /sh/ sound. In stories, before writing the standard spelling the next time she spelled the word, Beth spelled BEAT/boy, perhaps partially semiphonetic for b; TH/her, perhaps an analogical part from the; and DHTN/IDHT/the, a reversal of two letters with a prelíterate addition of two others. Before writing the standard spelling the next time she spelled the word, Kathy spelled TH/they in tests, which is perhaps a semiphonetic spelling or the standard spelling of a significant segment only. In stories, she spelled GL/girl, a semiphonetic spelling; H/HS/her, another semiphonetic spelling with perhaps an analogical borrowing from his; HWYS/horse, a semiphonetic spelling; PA/pig, a semiphonetic spelling; CSHT/STA/she, a combination of semiphonetic and prelíterate spelling; and WIA/WIE/with, perhaps a semiphonetic spelling.

Nor were the creative variations that followed a standard spelling simply a relapse to the spellings that have been identified with transitional or phonetic stages. After writing the standard spelling, Julian spelled PESTE/picture in stories, which is a scramble of four of the seven letters in picture plus s. After writing the standard spelling, Beth spelled SOG/dog, HEER/there then WPA/there in stories. Neither of these creative spellings has even an acceptable semiphonetic beginning although there appear to be visual influences for sog and heer. After

writing the standard spelling, Kathy spelled TRUICK/trick in tests, which seems to have an analogical part from truck. After writing the standard spelling, James spelled RAIND/riding in stories, perhaps in analogy with rain.

Furthermore, sometimes only visual influences appeared in the development of a child's spelling. For example, in Kathy's sequence for it in her stories--IT, IS, IT, IT, IT, THC and then 12 standard spellings--the influences for creative variations seem to come from other words, e.g. is and the rather than phonetic spellings. All of these creative spellings for it occurred during her first phase when most of her other spellings showed either semiphonetic or visual strategies. Similarly, in James's sequence for going in his stories: GOING, GO, GO, and then 4 standard spellings, the only apparent influence is another form of the word.

Discussion

In general, stage accounts of spelling development have focused on phonological strategies and have not presented evidence for visual strategies in much detail before the transitional stage. In contrast, these children showed evidence of using both visual and phonological strategies in a variety of detail for spelling different words within the same phase and in different spellings of the same word over time. Even though there were individual instances of phonetic spellings, there was no period of time among the children in which "letters are assigned strictly on the basis of sound." Nor did "transitional spellers present the first evidence of a new visual strategy." Evidence of visual strategies, such as reversals, occurred well

before the transitional stage. Overall, these results show that these children have more flexibility in using visual strategies for spelling than would be expected from stage descriptions like Gentry's for spelling development.

In addition, the patterns of spelling development that we found are more consistent with multidirectional rather than with unidirectional views of written language development (cf Stotsky, 1987). In the unidirectional view, writing development is accessed primarily through oral language, oral langugage influences written language but not the reverse, and all normal children should be instructed through this sequence. Gentry's account of spelling stages would be consistent with that view, even though he recommends frequent writing in the classroom. In the multidirectional view, writing development may be accessed through both written and oral language, each may influence the other, and instruction should provide for these different influences. Consistent with the multidirectional view, our study shows that children who are not physiologically impaired do not necessarily have to wait upon a certain degree of phonological sophistication before they can show detailed evidence, including reversals, for visual strategies.

In such a multidirectional development of visual and phonological strategies, we might expect some occurrences in which visual and phonological strategies were both used redundantly to create equivalent forms, and indeed there was some evidence for this. For example, Julian produced the following sequence for <u>going</u>: GON, GON then 4 standard spellings, then GOEN, GOING, GOINGN and 5 standard spellings. Before spelling

GOINGN, Julian alternated between standard spellings and phonetic spellings. GOINGN contains both the standard spelling for the inflected ending -ing plus the N for the phonetic spelling.

The appearance of these visual influences in the children's spelling may be at least partially explained by the experiences to which they were exposed. Children's reading strategies are strongly influenced by instructional strategies, and it is probable that spelling strategies can be similarly influenced (Marsh et al., 1980). For example, Bissex's (1980) son often asked for, and was told, the letters that made a particular sound. By contrast our children repeatedly saw the standard spellings in their Direct Copy and Spell programs. It should not be surprising then if children's spelling development is affected by instructional programs on the computer. In particular, it would appear that programs like the ones we used are a viable option for teachers who want to develop the visual spelling strategies of young children.

One reason for teachers to encourage visual spelling strategies is that all children need to adopt visual strategies eventually in order to be good spellers. There are also reasons for teachers to encourage an early development of visual as well as phonological strategies. Some children may prefer one strategy to the other, and presenting children with instructional conditions that support both strategies allows them to pursue that preference. In addition, having both strategies available may produce mutually beneficial results. Phonological knowledge may be used to assist visual knowledge, e.g. to prevent the reversal of accurately recalled letters; and visual knowledge may

be used to assist phonological knowledge, e.g. to learn alternate letters and letter combinations for the same sounds.

Further research, of course, is needed to determine which features of the computer programs we used are most helpful in developing visual strategies. It may be the case, for example, that simply typing words on a computer keyboard will generally facilitate visual spelling. The computer has exceptional capabilities for making children aware of letter relationships in spelling. With no demands on handwriting and the fine motor control it entails, children can direct more attention to the spelling of a word. The letters in the words they spell also look more like the letters in their reading texts, which means their spelling is more readable. This allows children to more easily use information from reading in checking their spelling of words. The easily erasable words typed on a computer are also easier to revise, making it easier to spell words in different ways and to select what looks best. Writing down alternative spellings is a common adult practice that is recommended in theory (Simon & Simon, 1973) and supported by empirical research (Tenney, 1980).

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TABLE 1

CONTRASTIVE EXAMPLES OF CHILDREN'S SPELLING IN THEIR STORIES

STUDENT	FIRST PHASE	LAST PHASE
JULIAN	THE DOG WOS IFTR THE CAT ("The dog was after the cat.")	THE BOY IS RIDING HIS BIKE. THE GIRL IS RIDING HER BIKE TOO.
BETH	A BEAT YULR TO UEYLLRPEAQBBURSAE ("A boy ran to the tree.")	ONE DAY THERE WAS A BUNNY AN A GIRL AND THE BUNNY SAW THE GIRL AND THE GIRL SAW THE BUNNY
KATHY	TH GL J H APPL N THE GKR AND THE HWYS A IT ("The girl dropped her apple in the grass and the horse ate it.")	The girl is playing in the sand and she saw a bunny.
JAMES	THE FIHA IS SIMEN IN THE WATR INA DNA THE BOY IS IN THE BOT AND THE BOT IS FALIN FOER AWAEO. ("The fish is swimming in the water and the boy is in the boat and the bird is flying far away.")	the hill is in the air and the sun is in the air and th three birds are in the air and the house is on the ground and the fence is unde the house.

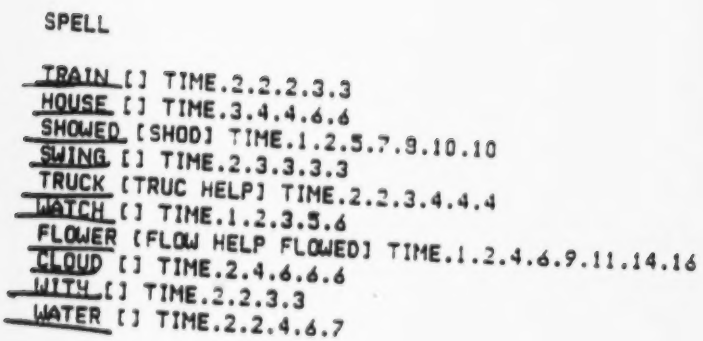

Figure 1. An example of a printout of the record of key presses for the SPELL program. Time refers to the cumulating number of seconds after the word is presented and after each subsequent key press until the word is spelled correctly. Underlined words were correctly read back aloud without help.

IT IS ROININ ON THE BOY.
IT IS RAINING ON THE BOY.

Figure 2. An example of a printout of the pictures and sentence with the Word Pictures program. The first sentence was written by the child without help, and the revision is underneath it. Underlined words were correctly read back aloud without help.